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Award Number: W81XWH-10-1-0819

TITLE: Enhancing Emotion Regulation during Driving in OEF/OIF Veterans

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REPORT DATE: January 2013

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Approved for public release; distribution unlimited

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
January 2013

2. REPORT TYPE
Annual

3. DATES COVERED *(From - To)*
27 September 2010 - 26 September 2012

4. TITLE AND SUBTITLE
Enhancing Emotion Regulation during Driving in OEF/OIF Veterans

5a. CONTRACT NUMBER

5b. GRANT NUMBER
W81XWH-10-1-0819

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Palo Alto Institute for Research and Education
Palo Alto, CA 94304

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The proposed project aims to develop and test an intensive rehabilitative technology aimed at enhancing emotion regulation and reducing operator-related risk during civilian driving in OEF/OIF returnees burdened by severe driving-related distress and disability. This in-car technology will have two main components. The first is a system for measuring driving behavior (accelerator and steering wheel movements, lateral and longitudinal vehicle accelerations), visual attentional control, and autonomic arousal during actual driving. The second is a cognitive-behavioral intervention combining breathing retraining/heart rate variability biofeedback and cognitive reappraisal. Both components are compatible with on-road driving assessments currently performed by driving rehabilitation specialists at our VA Health Care System on neurologically intact patients and those with mild-to-moderate non-focal traumatic brain injury.

15. SUBJECT TERMS
Driving, Stress, Behavioral Treatment

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			USAMRMC
U	U	U	UU	7	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

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INTRODUCTION

The proposed project aims to develop and test an intensive rehabilitative technology aimed at enhancing emotion regulation and reducing operator-related risk during civilian driving in OEF/OIF returnees burdened by severe driving-related distress and disability. This in-car technology will have two main components. The first is a system for measuring driving behavior (accelerator and steering wheel movements, lateral and longitudinal vehicle accelerations), visual attentional control, and autonomic arousal during actual driving. The second is a cognitive-behavioral intervention combining breathing retraining/heart rate variability biofeedback and cognitive reappraisal. Both components are compatible with on-road driving assessments currently performed by certified driving rehabilitation specialists (CDRS) at the VA Palo Alto Health Care System (VAPAHCS) on neurologically intact patients and those with mild-to-moderate non-focal traumatic brain injury.

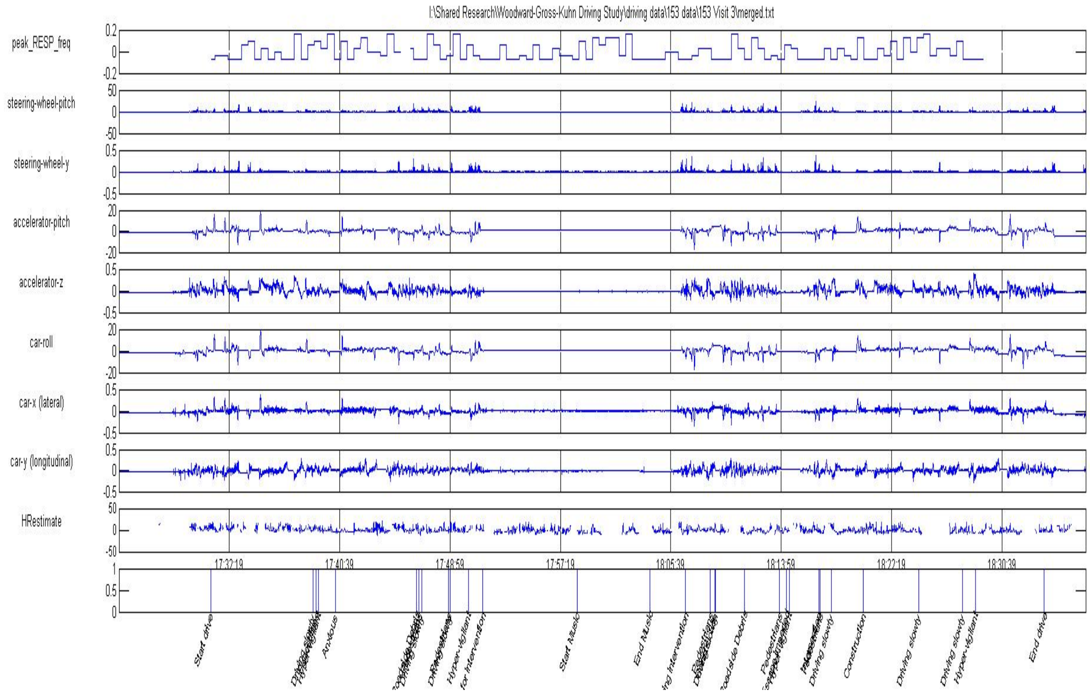
KEY RESEARCH ACCOMPLISHMENTS:

1) Technical Developments

The period covered by this report saw the development of a less costly, far more user-friendly, and in many ways more capable in-car driving measurement system than was envisioned or initially developed for this study. These advances were due in large part to input from Fujitsu Laboratories of America (FLA), who was informed of our project by another VA/DoD/CDMRP investigator, and saw it as a beta–test opportunity for a data integration technology internally called the “Sprout.” This collaboration was covered by a research agreement between FLA and the PAIRE and approved by USAMRMC contracting. The Sprout is a tiny, battery-powered, one-board Linux computer optimized for interfacing with wearable sensors and for streaming, synchronizing and storing data from several such sensors. It can be managed wirelessly from a web-browser. FLA also supplied small mobile applications enabling a driving measurement system in which Apple iPod Touches were substituted for the wireless accelerometers we had been using, and a Zephyr Bioharness, already in use by the military, was substituted for our ECG subsystem. An iPhone 4s hosted an app that managed the Sprout and its connections with IPods and sensors, enabled real-time signal monitoring, and supplied both GPS data and behavioral codes back to the Sprout for merging with the car and driver data streams.

The Sprout/iPod/iPhone system provided for familiar and friendly application interfaces and high portability. It also eliminated the problem of data integration/synchronization across platforms. The summary output of a typical driving session is presented in Fig. 1. Following on developments in the fast-moving smartphone/tablet market, this system will soon be functional on Android platforms, and be extensible to new sensors and platforms as they become available. We are currently exploring two such extensions. First, we are collecting point-of-view video from participants during driving which provides qualitative information regarding gaze content (e.g. before or during a spike in arousal or apparent distress) and gaze direction. While our original gaze-tracking system cost approximately $20,000 and did not collect gaze content, the POV video camera cost only $130. Second, we are exploring whether the larger screen of an iPad would enable a driving rehabilitation specialist, working alone, to input behavioral codings while monitoring drive safety, conducting the rehabilitation session, etc. In summary, the smaller, friendlier, more capable, and more disseminable system developed during this reporting period should cost less than $2,000 including estimated cost for the Sprout (~$250).

Fig. 1



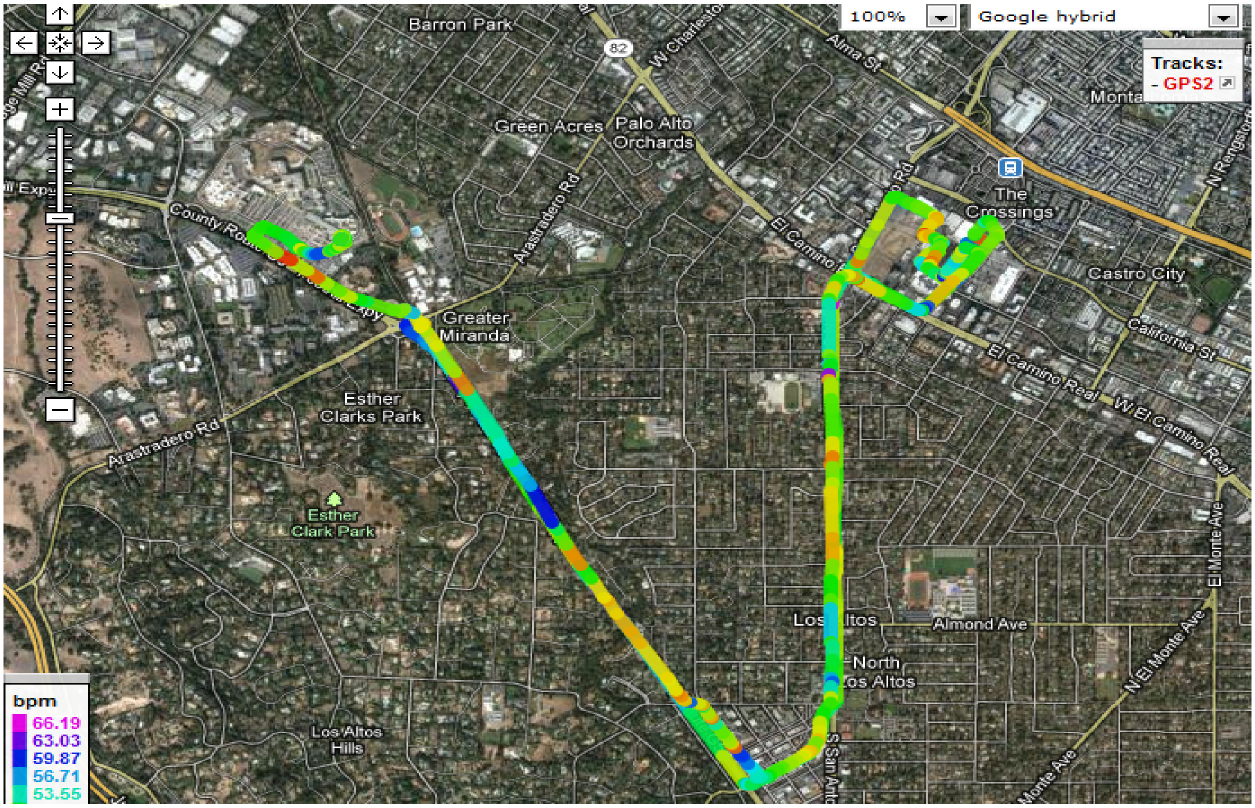
2) Treatment Delivery

While a CDRS-only treatment format would reduce cost and scheduling barriers, we still anticipate that a PTSD expert would be involved in the assessment of combat driving trauma and the development of a hierarchy of civilian driving triggers, followed by a "warm hand-off" to the CDRS.

3) Measurement-Guided Driving Rehabilitation

A guiding principal from the inception of this project was that objective measurement of driving behavior and driving-associated autonomic activation would prove useful in judging treatment progress. While we remain convinced that the ecological validity of in-car measurement and an in-situ treatment have irreducible advantages for those patients who can tolerate them, it is also true that unanticipatable events out on the road can and will interfere with driving measurement. To address this problem, we have introduced the practice of including standard road sections in all drives. This is quite easy as the hospital is served by a finite set of local roads. The fully-merged and synchronized GPS component of our current system allows the precise tagging of driving and driver data from these standard sections. Moreover, it has become apparent that we should be able, over time, to accrue a normative database of driving parameters over these sections that describe abnormal driving in a more objective manner, bringing more capabilities of simulator to the ecologically valid, on-road context. Fig. 2 illustrates the mapping of heart rate from one participant during a drive on roads near the hospital.

Fig. 2



4) Testing Progress

Screens, exclusions, enrollment and completion data are contained in the following table.

		Total Screens	Excluded Screens	Positive Screens	Enrolled	Completers
2011 Q2	Jan-Mar	0	0	0	0	0
2011 Q3	Apr-Jun	12	8	4	1	0
2011 Q4	Jul-Sept	10	6	4	7	1
2012Q1	Oct-Dec	3	2	1	1	2
2012 Q2	Jan-Mar	5	2	3	1	1
2012 Q3	Apr-Jun	8	3	5	4	2
2012 Q4	Jul-Sept	11	6	5	2	4
2013Q1	Oct-Dec	11	6	5	2	0
2013 Q2	Jan-Mar	5	2	3	1	1
Total		**65**	**35**	**30**	**19**	**11**

Recruitment has continued to run far below what we anticipated given the prominence of driving distress in clinician reports, in the media, etc. This situation has persisted despite wide-spread flyering, in-person outreach by both the PI and coordinators, and the exploitation of clinician contacts throughout the VISN.

REPORTABLE OUTCOMES:

The blind for this preliminary RCT has not yet been broken. Reportable outcomes are principally those described above under Technical Developments. The blind will be broken within the next month and preliminary between-group findings will be included in the Final Report.

CONCLUSION:

The need for effective approaches to reducing driving risk in recently deployed veterans has been highlighted in the published findings of USAA, an insurer of many US military staff, veterans, and dependents. Their actuarial data shows that OEF/OIF/OND deployment has been associated with substantial, rank-dependent increases in claims arising from at-fault accidents. Nevertheless, the difficulties we have faced in recruitment for this study raises a serious question as to whether veterans would access such a service if available. In the short term, further developments of this approach may be accelerated by accessing a more dependable participant pool. In that spirit, we note that our in-car technology might add a second level of measurement-guided treatment to a stepped-care approach to driving rehabilitation for polytraumatized veterans who begin in the simulator. We are actively exploring this possibility.

REFERENCES: N/A

APPENDICES: N/A

SUPPORTING DATA: N/A